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ABSTRACT

This paper compares the visual and auditory perceptual systems as bases for communication systems, reviews advances in computer technology, and considers implications for literacy among persons with hearing impairments. It is pointed out that the primary language skills of hearing individuals are developed through speech and language (auditory perception) and then transferred to the written form (visual perception), and that visual communication systems inherently contain some ambiguities (among them the irregularities of English spelling). Studies suggesting that the printed word is the most stable of the visual symbols used by hearing-impaired children are noted. Technology is seen as an important potential ally in the language development of children with hearing impairments, through providing new and different experiences that associate language symbols with prior experience. Specific computer programs and interactive video programs are described. It is stressed that the computer programs being developed for literacy training for the hearing impaired should involve increasing the amount of linguistic interaction available to the child. (DB)

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LITERACY AND THE HEARING IMPAIRED: LIVING, MOVING, DYNAMIC TEXT

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The hearing impaired person must rely upon the visual system for his or her major communication needs. Therefore, it is essential that we define the characteristics of visual perception and note weaknesses and strengths with respect to communication skills. If we compare auditory and visual sensory systems, the most obvious difference is that the auditory system is a global. That is, signals can reach the person from any direction, 24 hours a day. The auditory system is primarily an early warning system that is always "on". On the other hand, the visual system is directional rather than global and dependent upon sufficient light sources. To use the visual system the person must turn it on (open your eyes) and direct it to the source of the stimuli.

The hearing person, of course, develops his language and communication skills through hearing and speech. The global nature of the hearing sensory system means that the infant is embedded in a sea of meaningful sounds that he can not turn off. Once language and speech patterns are established, they are transferred to the visual system through the development of literacy skills.

The creation of written symbols was a giant leap forward for society. It meant that accurate, stable, and permanent records of the knowledge and experience of civilization could be transferred over time and distance. Ideas developed in one part of the world

could be shared with others who never came in direct contact with the original thinkers. Moreover, ideas and events that happened in one generation could be shared with following generations.

The primary language and communication skills of the average person are developed through speech and language and then transferred to the written form. As a beginning reader discovered, "Oh! Reading is just talk in a book." This shows great insight on the part of the young learner.

Since communication skills were built on oral and aural systems, certain safeguards have developed to assure clear communications. There is redundancy built into the signal so that when the speech signal is buried in noise the receiver can fill in the blank spots. This is partially done by grammar and by phonetic clues.

On the other hand, visual communications, whether they are in the form of speech reading, finger spelling, or sign language, have a number of ambiguities that act as noise in the signal. As noted earlier, the receiver must be looking at the sender and the light must be sufficient for vision to work. Obviously, communication skills do develop among the hearing impaired and there is no question that visual communication systems can be the primary system. Oral/aural, oral/visual, and manual/visual common communication systems are eventually associated with the more stable written format of language.

The printed word developed differently in different parts of the world. One system was based upon pictographs and ideographs

and the other on phonetic representations of the sounds. Pictographic and ideographic systems are still used. The average Japanese, for example, must learn several thousand different symbols to become literate. On the other hand, the nations that use phonetic alphabets must learn the letter that represents the sounds of the language.

English spelling is a particular challenge to literacy since it is based upon a phonetic principle, but has many discrepancies. Consequently, the spelling of many English words must be learned by rote because in some instances words like "women" are not faithful phonetic representations. "GHOTI" for a new reader of English could logically be the spelling for FISH. They would associate the "gh" as the sound in enough, the "o" as the sound in women, and the "ti" as it is pronounced in nation. English spelling is simply not a faithful one-to-one phonetic language.

On the other hand, finger spelling is a one-to-one manual/written communication system that faithfully represents the printed word. Among other reasons for this problem in English was the invention of the printing press which fixed spelling in printers fonts and left us a legacy of non-phonetic spellings. English has 44 phonemes which are represented by the 26 letters of our alphabet. But we do not consistently combine the letters to represent the sounds. Some sounds are represented by several different letter combinations. Simple examples are that both f and ph represent the "f" sound and that gh represents the "f" sound at the end of words. This causes problems in developing high levels

of literacy in hearing people. The United States has one of the highest illiteracy rates of any developed nation in the world.

There have been many reformers who would have corrected our alphabet and given us a more precise system. Alexander Graham Bell developed an alphabet entitled visible speech. This was a three case system that provided information on where the lips, tongue, teeth, voice, breath, and nasal aspects of the phonemes were produced. This system was used extensively in transcribing languages that did not have a written form. George Bernard Shaw left his estate to the reform of English spelling to make it more phonetic, and Sir James Pitman has long sought a more scientifically based written system. Ironically, these reforms have been fought by the status quo of our society even though we pay a high price in illiteracy because of it. It just may be that the computer revolution will facilitate some of the needed reforms. Both synthesized speech and computer analyzed speech could be facilitated by a better alphabet and spelling system.

We have been able to translate print into speech and are working on speech into print. There are available on the market today print to speech machines and promising speech to print machines.

Barbara Tuckman was asked what were the most important technologies modern man had developed to increase literacy. Her reply, much to the dismay of computer and technology experts, was that in her opinion the greatest technologies to enhance universal literacy were (1) the electric light and (2) wearable eye glasses.

The electric light meant that reading could take place at any time during the 24 hour day and wearable glasses meant that people could read for their entire lives, regardless of the physical changes we all suffer with age. When you think about it this is a very profound answer. These technologies essentially expanded the available time on task for people to read. I have tried to set the stage for the use of print technologies in the education of hearing impaired youngsters by discussing the nature of literacy in general. In summary, the young hearing child develops through many associations within the environment a speech and language system that associates real experiences with speech symbols. Once that system is developed reading and writing are developed on top of the speech and listening system.

The hearing impaired child, even if he or she is making maximum use of residual hearing, must develop a language based upon visual symbols. In most education programs there is a synergy among the spoken, signed, finger spelled word or language concept and the referent in the real world. As a matter of fact, during the development stages the printed symbol is also associated with the event. There are a number of studies that indicate that the printed word is the most stable of the visual symbols used by hearing impaired children.

Technology provides us with a wide range of visual print symbols that can carry a richer meaning. For example, if we added color to closed captions we could assign a specific color for male voices and one for female voices. The captioning techniques of

today place the captions near the speakers. Voice over narration is indicated by placing the caption at the top of the screen. Music is indicated by "note quotes" around the sung portion of the program, etc. Obviously, there are a number of additional refinements that can be made. In a play, if male and female voices are coded by color, individual characters could be assigned different type fonts. J.R. in "Dallas" is always blue and with a geneva type font etc.. Captioning may be one of the most important services offered hearing impaired people. It provides them with a massive amount of language usage associated with story and action experiences on television.

Language development remains a problem for hearing impaired infants and children. Traditionally we find that most hearing impaired children, regardless of the location of their school, remain three or more years behind their hearing peers in academic achievement. Much of this lag is dependent upon development of sophisticated language skills. Technology offers us the ability to provide new and different experiences that can associate language symbols with experience. For example, interactive video-discs or DVI CD-ROM interactive programs can provide individual study stations that give the user a multiple linguistic experience. It is possible to develop a program that provides for language building experiences and allows the user to experience the program through auditory and speech symbols, finger spelled symbols, total communication systems, or American Sign Language at the flip of a switch. All can be associated with captions.

Text on screen is not limited to the traditional book text format. Words can pop on the screen, move, and indicate their meaning. For example, in "Sesame Street" and "The Electric Company" we had words that animated into their referents. FAT grew fat until it covered the entire screen, THIN became tall and thin. Other words such as angry, cry, happ, etc., animated into characters that identified the state of feeling; verbs actually took on their meaning. FLY began to flap and fly around, WALK began to walk etc..

In the mid 1970's, I was particularly interested in the ability of the computer to animate and change words into their referents. I took sentences, such as: **The butterfly flew around the flower** and as the words were said they changed into their meaningful referents, i.e., the word "butterfly" became a butterfly when it was said, "flew" (the word and the butterfly began to fly), "around" began to circle and "the flower" turned into a flower. The final scene was a butterfly flying around a flower and the caption changed to: **The butterfly is flying around the flower.**

In today's world of technology we might have this happen as the learner reads the sentence into the microphone or as the learner types it into the system. The beauty of today's technology is that it can be immediate and interactive.

Margaret Withrow and Charles Csuri of Ohio State University's Computer Graphic Center created a series of computer-generated programs that allowed learners to experience a number of language concepts. These programs cue captions to auditory signals

and language concepts.

Another computer-generated series of programs were experimented with at the National Technical Institute which in one instance gave the learner control over a "Star Trek" program. To save the universe from the Klingons the user had to work mathematical problems for the Captain. Another was a job interview. The last one used Withrow and Csuri created computer animated characters. The learner could either describe what was happening or command the animals to do certain things within the limits of the computer's animated world. Most learners loved to command the animals. There was a certain degree of argumentative dialogue that went along with the program. For example, when the learner logged onto the program, a series of weather questions were asked and if the temperature was 20 below zero, snowing, and windy then the animals respond accordingly. If, for example, you ask the frog to swim, the computer asks you if there is an indoor pool, etc.. There is an Empire State building in the computer's animated environment. You can, of course, ask the frog to jump over the building...the frog will argue and finally attempt to jump, but of course hits the walls and ends the game. If you asked the frog to fly the computer might ask you how many wings the frog had or if you are willing to buy the frog an airline ticket. The learner entered the program through the keyboard. Today, or in the near future it would not be impossible to enter such programs through voice analysis.

Interactive video programs could create a dictionary that

enabled the person to receive a moving example of the word, a spoken example of the word, a finger spelled example and a signed example of a word on demand of the learner. Such an interactive dictionary would be meaningful not only to hearing impaired students, but other learners who have not mastered literacy fully.

Much of the work in applying technology to educate hearing impaired youngsters has been directed towards providing more linguistic experiences for them. In the 1960s, Robert Step at the University of Nebraska developed interactive 8mm films shot from the viewpoint of the young child and provided a number of manipulative activities for the young child and provided a number of manipulative activities for young deaf children to speech read. Withrow's Lip reading films were done in conjunction with the University of Nebraska and the Illinois State School for the Deaf. These were single concept films developed to provide experiences and increase vocabulary. PROJECT LIFE was developed to again provide language experiences through technology.

John Gough, Gilbert Delgado, and Malcolm J. Nowrood, through their leadership in captioning techniques, explored many avenues for creating more new linguistic experiences for the hearing impaired population. George Propp and Robert Step were pioneers at the University programs and were on the cutting edge of design for interactive videodiscs.

The key to captioned television for the hearing impaired and the development of computer programs for literacy for the hearing impaired is that they increase significantly the amount of

linguistic interaction available to a young hearing impaired child.

If we look at the history of education of the hearing impaired children, we can see that many of our forbearers explored a wide range of technological and scientific applications to education of the hearing impaired. Obviously, Alexander Graham Bell contributed much in this area through the telephone; however, his understanding of speech, literacy, and print may have been a greater contribution. Many of the pioneers of education of the deaf, such as Edith Fitzgerald and her peers, developed technologies of form and structure that assisted in the development of language for the deaf.

The Regional Media Centers for the Deaf and their drive to teach teachers of the hearing impaired to use among other things, the overhead projector as a blackboard increased the teacher-pupil interface time. A teacher of the deaf who turns to the blackboard to write loses contact with the pupil. A teacher using an overhead projector maintains contact.

This year will mark forty years that I have been interested in the use of technology to reinforce education of hearing impaired youngsters. In that period of time, we have seen great advances in technologies. Today, we can develop a wide range of universally available learning tools that will increase the quality of education for all hearing impaired people. Today, we have a mature captioned television program with more than 200 hours of available programs that we can view each week. We have the opportunity to expand that service by looking at more efficient formats of

captioning. There are a number of excellent captioned educational materials available for the classroom teacher to use.

I would like to see greater development of computer and interactive laser technologies used in education of the hearing impaired.

I would like to see a more rapid conversion of TDD systems to ASCII codes so that the hearing impaired will have more universal access to electronic systems. I would like the development of more sophisticated uses of language in interactive programs. There is a continuing need for upgrading teachers' skills in using new technologies. I would like to see programs take advantage of distance learning technologies to reach the professional community.

There is much to do and it should be challenging. If we solve some of the literacy problems among the hearing impaired, we may also be working to solve literacy problems in the total community. We can ill afford to remain a nation that does not work to make the best of all of our human talent. We cannot allow significant numbers of our citizens to remain illiterate.

The door to achievement for hearing impaired people is the development of good literacy skills. That is the ability to read with meaning and to write with a critical eye to the knowledge they have.